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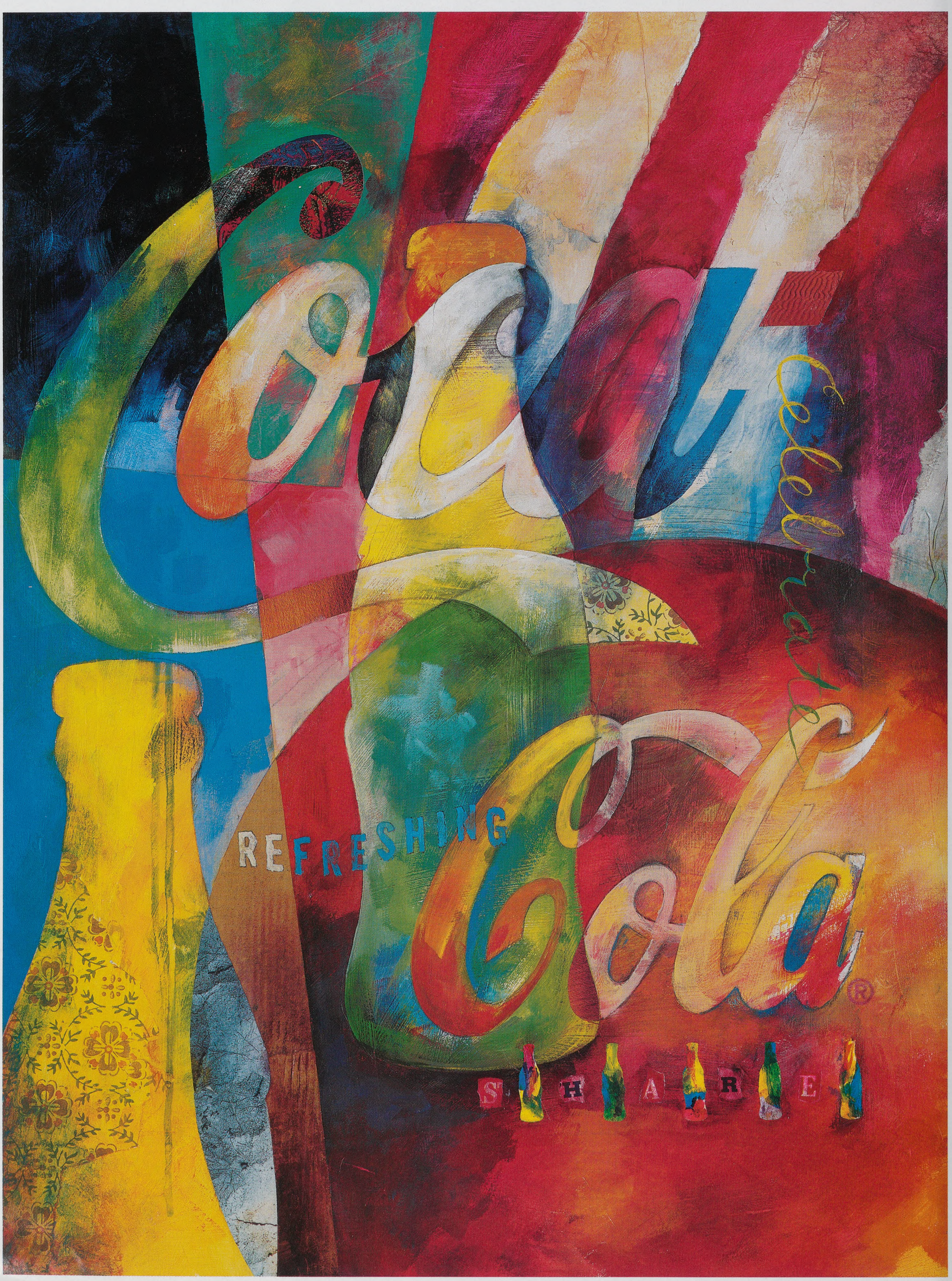
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November/December 2004 | Volume 33, Number 6

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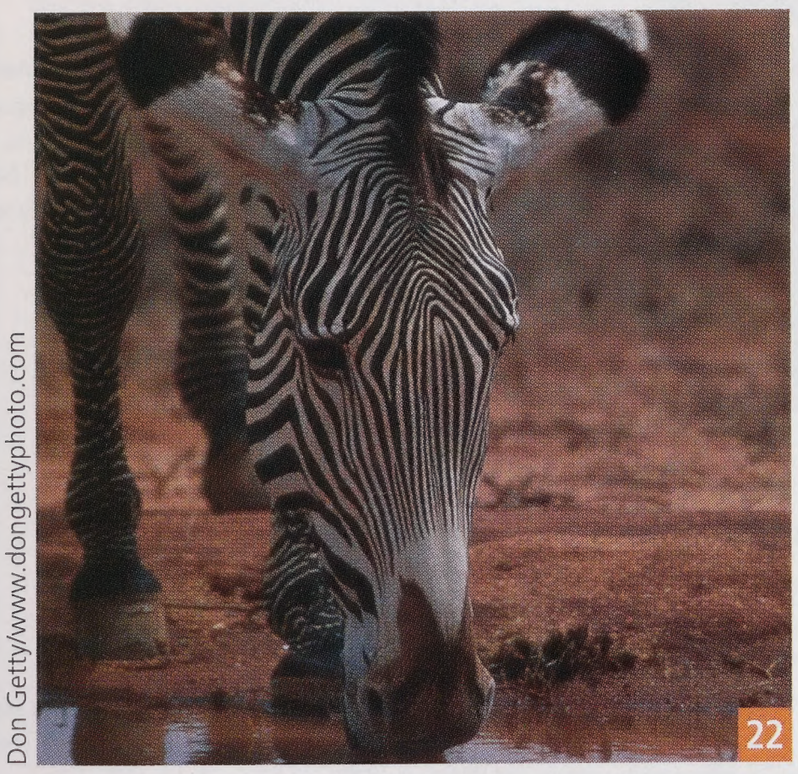
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FONZForum

Support for Small-clawed Otters

As frequent visitors to your National Zoo, you probably know that construction of the Zoo's new Asia Trail is well underway. By mid-2006, you will be visiting the state-of-the-art Fujifilm Giant Panda Habitat as well as innovative new exhibits for sloth bears, clouded leopards, fishing cats, and giant salamanders. As construction on these exhibits proceeds, we are immersed in designing two more exhibits that will complete Asia Trail: a magnificent new Asian elephant habitat and a wonderful wetlands habitat for Asian small-clawed otters. We are looking to FONZ members to help make the new otter habitat a reality by contributing generously this holiday season.

Asian small-clawed otters are delightful animals, always active, playful, and curious about everything. Their current exhibit in the Small Mammal House is adequate for Bert and Wheezie, our male and female pair, but the new habitat we are designing will be spectacular. The outdoor habitat will be 3,000 square feet, divided into three yards. One will contain a large pool with a cut-away so visitors can see the otters underwater; another several streams; and the third a flooded wetlands area. With this diversity, visitors will see how these water-loving animals behave in the various habitats they occupy in the wild. The outdoor space will also offer a variety of climate-control features, such as hot spots and heated dens visitors will be able to see into, so the otters, which are native to tropical Asia, can be outside during the winter months.

Jessie Cohen/NZP

The new exhibit will have space for as many as three extended families of small-clawed otters, and we hope this new habitat will encourage our otters to breed. The status of small-clawed otters in south and Southeast Asia is uncertain, but their numbers are declining as their habitat shrinks and the wetlands they depend upon are increasingly polluted. And the number of small-clawed otters in North American zoos as part of the American Zoo Association's Species Survival Plan is only just over 100. So bolstering the zoo population is essential to providing an insurance plan against their extinction in the wild.

In the next few weeks, you will receive a mailing from me with more information and a request for a contribution to the creation of this exciting new exhibit on Asia Trail. I urge you to support the Zoo's revitalization, and our efforts to celebrate, study, and protect animals and their habitats, with a generous donation. Thank you.

Happy holidays!

Sincerely,

Tom LaRock, Executive Director

Statement of Ownership
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FONZ Friends of the National Zoo is a nonprofit organization dedicated to supporting the conservation, education, and research efforts of the Smithsonian's National Zoo. Formed in 1958, FONZ was one of the first conservation organizations in the nation's capital. Friends of the National Zoo is dedicated to supporting the National Zoo in a joint mission to study, celebrate, and protect the diversity of animals and their habitats.

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Smithsonian **National Zoological Park** is located at 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537. Weather permitting, the Zoo is open every day except December 25. Hours: From April 3 to October 31, grounds are open from 6 a.m. to 8 p.m.; buildings, 10 a.m. to 6 p.m. From November 1 to April 2, grounds are open from 6 a.m. to 6 p.m.; buildings, 10 a.m. to 4:30 p.m.

Membership in FONZ offers many benefits: programs, publications, discounts on shopping and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537, call 202.673.4961, or go to www.fonz.org.

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Cover photo: This maned wolf (*Chrysocyon brachyurus*) is one of three brothers that are now on exhibit at the National Zoo. They were born at the Zoo's Conservation and Research Center in Virginia. Photo by Jessie Cohen/NZP.

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The Smithsonian's National Zoo is accredited by the American Zoo and Aquarium Association.

Letter from the **Zoo Director**

Leading by Example

Great zoos set and meet the highest standards for animal care and exhibition, provide habitats that encourage natural behavior and breeding, allow visitors the opportunity to see animals they might never see in the wild, and serve as laboratories where long-term studies of animal health, reproductive biology, and behavior yield results that support their management and conservation. Great zoos conduct field-based research, conservation, science education, and professional training programs; shape public opinion by educating and motivating people to take action to protect wildlife; and collaborate with each other, and with nongovernmental organizations involved in wildlife management, science, and conservation around the world. Great zoos also lead by example.

Jessie Cohen/NZP

In the broadest sense, the question at the heart of the Smithsonian National Zoo's new strategic plan* is: What are the elements of a great, national zoo? The bold founding vision (1889) for the National Zoo established a path to greatness for the Zoo in the 20th century: "a home and a city of refuge for the vanishing races of the continent." Its founding mission set an example for the nation: "the advancement of science and the instruction and recreation of the people."

As the National Zoo enters the 21st century, its reputation as a "great zoo" is in question. Planning for the future and financial investment in the Zoo have been inadequate for many years. Operating budgets are lean and the Zoo's facilities have aged without maintenance. Many of the exhibits no longer provide high-caliber habitats for the animals, the number of staff and animals has declined, and the Zoo's capacity to teach and train has been reduced. Scientific contributions by Zoo staff are well known within the research community, but not by the general public, and are reflected in only a handful of exhibits.

With efforts well underway to reverse these trends and rejuvenate the organization, the National Zoo is poised to build a new path to greatness. As animals and their habitats continue to disappear, the Zoo is reshaping its vision. Just as all zoos strive to be great stewards of the animal world, the National Zoo must again lead by example and extend its reach, globally. This new vision and plan are designed to firmly establish the National Zoological Park in its pre-eminent role as the nation's Zoo and as an international leader in zoo-based science, conservation, and education. They are also designed to build upon the Zoo's strengths and opportunities, and set priorities for future financial investment.

Dedicated staff and supporters, inspired by the success of the Zoo's first 100 years, crafted this new vision and strategic plan. Together, they outline a challenging journey that will require a sustained effort on the part of many.

Sincerely,

Lucy H. Spelman

Lucy H. Spelman
Director, Smithsonian's National Zoological Park

**The National Zoo's strategic plan is highlighted on pages 8-9 of this issue.*

Notes&News

Three maned wolf brothers are now on exhibit at the Cheetah Conservation Station. They resemble large foxes on tall, slender legs.

All photos this page: Jessie Cohen/NZP

Animal News

Tiger cubs Marah, Jalan, and Besar are no longer the newest triplets at the Smithsonian's National Zoo. That distinction now belongs to three **maned wolves** (*Chrysocyon brachyurus*) on exhibit at the Cheetah Conservation Station. The two-year-old brothers, which came to the Zoo in August, were born at the Zoo's Conservation and Research Center in Virginia. Zoo scientists have studied maned wolves for more than 25 years, and also conduct field studies in the wolves' native habitat in South America. To learn more about the Zoo's work with maned wolves, turn to page 14.

In a nearby exhibit, also at the Cheetah Conservation Station, two new **scimitar-horned oryx** (*Oryx dammah*) graze. These striking antelope have long, curved horns that can grow up to five feet in length. Hundreds of thousands of oryx once roamed the southern edge of the Sahara desert in Africa, but the species is now extinct in the wild because of hunting, livestock grazing, and drought. National Zoo scientists are working to return these and other desert antelope to Africa. They pioneered artificial insemination techniques for scimitar-horned oryx, and are cooperating with zoos around the world to reintroduce them to the wild.

A scimitar-horned oryx.

Down the hill in Beaver Valley, two playful **North American river otters** (*Lontra canadensis*) are scampering around their newly renovated exhibit. With the addition of native plants and trees, the otter brothers have more places to relax, hide, dig, and play. They especially like to climb and rest on a naturalistic stump structure and slide, which replaced an old child's play set from the former exhibit.

When a female **water moccasin** (*Agkistrodon piscivorus*) gave birth to a live baby snake at the Reptile Discovery Center, Zoo scientists were puzzled. How could she have offspring when she had not mated with a male for more than a year? The mother may have retained viable sperm in her body for a whole year, until she was ready to bear young. Some female snakes can retain sperm for more than five years, until conditions are favorable for birth. Or, the baby may be the result of parthenogenesis, a fascinating reproductive phenomenon that occurs naturally in some reptiles, amphibians, invertebrates, and plants. If this is the case, then the baby snake developed from an egg that was never fertilized, and it may be genetically identical to its mother. One thing is certain—this is the first water moccasin born at the Zoo in more than 32 years.

Get the scoop on Zoo scientists' latest groundbreaking discoveries at **www.fonz.org/science.htm**.

Events

Evening Lectures

Free lectures at the National Zoo's Visitor Center continue to enlighten and inform throughout the fall. To find out more, sign up for email notifications about the lectures, or RSVP, please visit **www.fonz.org/lectures.htm**.

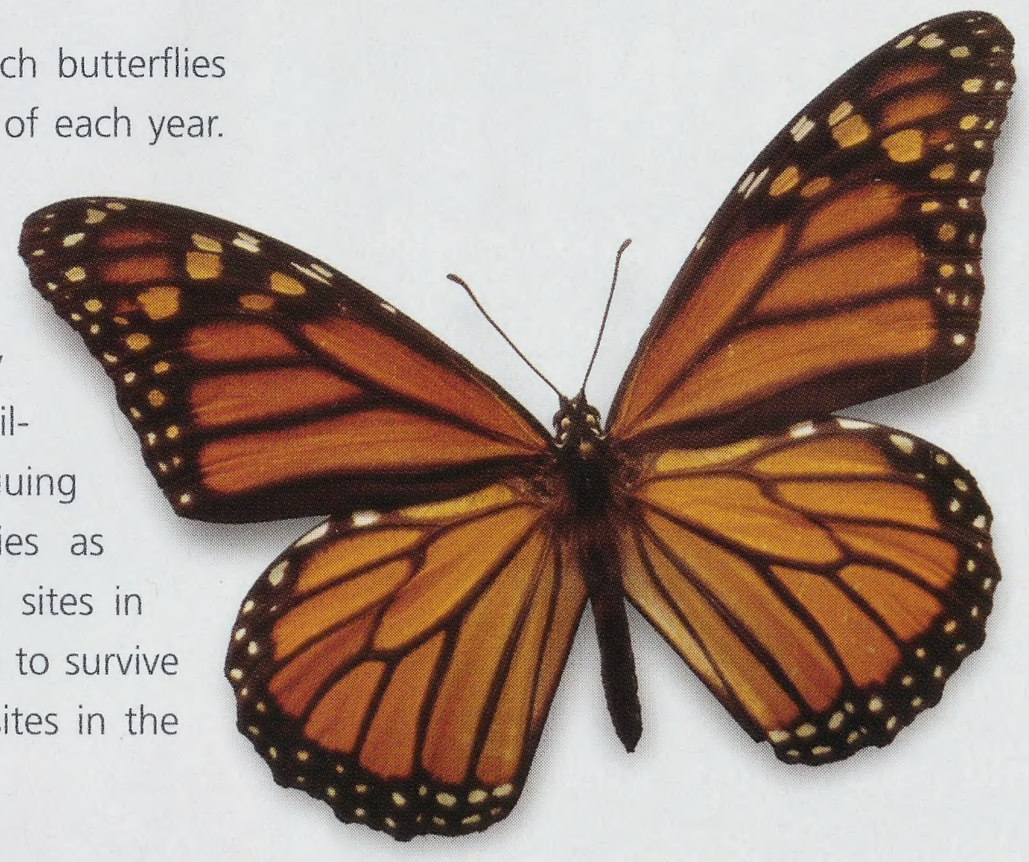
November 4: *Return of the Unicorns*. *Book signing at 7 p.m., lecture at 8 p.m.*
World Wildlife Fund chief scientist and Vice President for Science Eric Dinerstein will talk about the conservation biology of endangered one-horned Asian rhinos in Nepal, and the recovery of Asia's endangered large mammals. He will sign copies of his book *Return of the Unicorns*, a fascinating account of what it takes to recover an endangered species in Asia's human-dominated landscapes.

November 18: Saving Charismatic Asian Cats. *Lecture at 7:30 p.m.*
In this fascinating, slide-illustrated lecture, National Zoo reproductive physiologist JoGayle Howard will explain the Zoo's efforts to conserve clouded leopards and fishing cats, two of the most charismatic and least understood of Asia's many beautiful cat species. Challenges to the field studies include poaching and human encroachment into protected areas. Don't miss this glimpse into the Zoo's important role in conservation in Asia.

December 2: Treasures of the Monarch Butterfly. *Lecture at 7:30 p.m.*
More than 300 million monarch butterflies fly south to Mexico in the fall of each year. National Zoo conservation biologist Alfonso Alonso, deputy director of the Monitoring and Assessment of Biodiversity Program, will present a slide-illustrated talk about the intriguing biology of monarch butterflies as they migrate to overwintering sites in Mexico and how they manage to survive and return to their breeding sites in the southern United States.

Children's Holiday Celebration

December 11, from 12 to 4 p.m.
Help FONZ spread holiday cheer at this festive celebration. Kids can enjoy performances from the Blue Sky Puppet Theatre, as well as animal demos, crafts, and refreshments. Admission is free, and the general public is welcome. We encourage you to bring a donation of a gift for a needy child.



Volunteer Corner

Emily Schuster

FONZ teen volunteer Elizabeth Scroggs helps kids at the *How Do You Zoo?* exhibit.

Emily Schuster was the teen program coordinator for the How Do You Zoo? *exhibit in the Visitor Center this summer. Here, she explains why she volunteered, and what she and the teens gained from the experience.*

"I started volunteering at the Zoo as a shy teen in 1988. During my four years as a teen volunteer, however, the confidence I gained at the Zoo spilled over into other areas of my life. After all, I knew that if I could talk to complete strangers about the Amazon rainforest, I could raise my hand in English class, too.

This past summer, I had the wonderful opportunity to work as the *How Do You Zoo?* teen program coordinator. My teen volunteers helped inner-city children role-play zoo careers in the *How Do You Zoo?* exhibit.

When I began this job, one of my personal goals was to help a teenager grow in the same way I had. By the end of the summer, though, so many of them had grown beyond my expectations. One volunteer, who disliked public speaking and was reluctant to lead the kids on a Zoo tour, found that the tour was his favorite part of the day. Two others said that they overcame some of their shyness, just as I did years ago.

In the summer of 2004, 159 teenagers in six major FONZ teen programs contributed more than 10,000 volunteer hours. Beyond earning service hours for school, these teens built leadership skills, gained work experience, learned about science, and made new friends. I was proud to get to know some of these remarkable young people this summer. The Zoo as a whole was privileged to benefit from their energy, enthusiasm, and dedication."

If you'd like to volunteer at the National Zoo, please visit ***www.fonz.org*** *or call 202.673.4956.*

HIGHLIGHTS

OF THE SMITHSONIAN NATIONAL ZOO'S

STRATEGIC PLAN

The National Zoo's new strategic plan is designed to firmly establish the organization in its pre-eminent role as the nation's Zoo and as an international leader in zoo-based science, conservation, and education. It builds upon the Zoo's strengths and opportunities, and sets priorities for future financial investment. At the heart of the plan are the Zoo's mission, core values, and 10-year vision of an exciting, compelling, successful, and attainable future.

MISSION

We are the nation's Zoo, providing leadership in conservation science. We connect people with wildlife through exceptional animal exhibits, explore solutions through science-based programs, build partnerships worldwide, and share our discoveries. We educate and inspire diverse communities so they become part of this commitment to celebrate, study, and protect animals and their habitats.

CORE VALUES

Unity - We are one Zoo. Our various organizations and departments work in unity toward a common vision.

Conservation - We are environmentally responsible. Our actions, practices, and programs contribute to conservation.

Staff - We invest in our staff. We value diversity and provide the resources, training, and skills needed to excel in our jobs. Every role is clearly defined and respected.

Communication - We communicate effectively. We ensure that the voices of our staff are heard and information is shared throughout all levels of the Zoo.

Excellence - We are professionals. We set the highest standard in caring for our animals and providing service to our visitors, communities, colleagues, and collaborators. We take responsibility for our actions.

Fun - We make being at the Zoo fun. Our positive attitudes contribute to an enjoyable experience for everyone.

It takes people to save wildlife. We inspire, train, and empower each generation to care for animals and conserve wildlife.

OUR IMPACT IS GLOBAL.

10-YEAR VISION FOR THE NATION'S ZOO

In 10 years, as visitors enter our urban oasis, they will be inspired by state-of-the-art, innovative animal exhibits that reflect our commitment to animal care, science, and public engagement. Exhibits will connect visitors with the natural world and immerse them in our real-life stories of wildlife conservation. Our outstanding volunteer, education, and international outreach programs will enable people to learn more and take a personal role in the future of wildlife.

Our professional internships and training programs will be sought after by highly motivated individuals, locally and internationally. Our apprentice programs will attract people from diverse backgrounds to learn the professions of a modern zoo. The National Zoo's facility in Front Royal, Virginia, will be fully utilized as a center of excellence in science-based conservation. We will be renowned for developing leaders in the fields of zoo management, veterinary care, conservation science, and education.

The National Zoo will be known for its long-term commitment to capacity building and training. We will share science-based tools and information, empowering local communities to conserve habitats and animals.

Our staff will be respected as leaders and mentors in zoo and conservation sciences nationally and internationally.

STRATEGIC PLAN CATEGORIES, GOALS, AND PERFORMANCE MEASURES

The plan's 1-year goals are the Zoo's highest priorities; they must be accomplished, regardless of current resource limitations. The 5-year goals represent the actions the Zoo needs to take to advance halfway toward realizing its 10-year vision. And the performance measures are designed to drive change and track the Zoo's progress toward achieving its short-term goals and, ultimately, its long-term vision.

Strong Financial Foundation

1-Year Goals

Funding priorities identified; leadership provided with materials and rationale supporting priorities; ambitious development goals set and met.

5-Year Goals

Federal appropriations, revenue, and external funds support the 10-year vision, including necessary staff, operations, and capital improvements; all revenue-generating activities are based on best business practices.

Performance Measures

Funds received from development and concession activities; profit margins met; successful in funding science and education priorities and master plan projects.

High-Caliber Animal Management

1-Year Goals

High-quality animal care and environments established; criteria-driven, cross-departmental, expeditious, and transparent collection and exhibit planning processes developed; databases ready for transition to the Zoological Information Management System.

5-Year Goals

Comprehensive, integrated electronic record-keeping systems fully functional; animal collections express Zoo priorities; staff recognized as experts and innovators; expanded training programs and collaborations in animal management and conservation instituted.

Performance Measures

Staff participating in professional organizations; scheduled preventive medicine procedures completed; animal moves and breeding decisions based on integration of science, education, exhibit, and facility priorities.

Recognized Scientific Excellence

1-Year Goals

Science priorities build on core scientific strengths; science and conservation activities clearly communicated in collection, exhibits, and education programs.

5-Year Goals

Zoo- and field-based research programs integrated; Center for Conservation Biology established; strategic partnerships built; training programs strengthened; capacity building and training expanded in countries where staff conducts research; science-based tools and information shared with local communities.

Performance Measures

Scientific staff serving as adjunct faculty, on graduate committees, and as sponsors of fellows; active partnerships with zoos, government agencies, and universities; projects integrating Zoo- and field-based research; multidisciplinary, partnership-based research programs focusing on extinction-prone species; peer-reviewed technical publications.

Comprehensive Educational Programs

1-Year Goal

Well-coordinated educational programs are driven by clear priorities.

5-Year Goals

Animal management, science, and conservation activities integrated into education program; education initiatives based on current practices and standards; all departments and units contribute to and receive resources for education efforts; interpretive programs expanded; mentorships, apprenticeships, and internships included in professional training; strategic partnerships built with other units.

Performance Measures

People reached; programs based on education research theory and evaluated using best practices; exhibits with active interpreter programs and science content; education programs collaborating with other units.

Extensive Public Impact

1-Year Goals

Distinctive visual identity created; Front Royal feasibility study and business plans completed.

5-Year Goals

Widespread recognition as one of the finest zoos in the country; collection, exhibits, and education programs reflect science and conservation accomplishments; actions, practices, and programs clearly contribute to conservation; exhibits and landscaping inspire and connect visitors to wildlife; accurate, up-to-date outreach materials and tools; outstanding visitor amenities and customer services; attendance significantly increased and new audiences reached.

Performance Measures

Monthly visitors; underserved and new audiences reached; new or updated web pages; successful news stories; up-to-date, well-maintained signage; complaints about visitor amenities, customer service, Zoo cleanliness, and overall aesthetics; standards-based exhibits; zoo management, conservation, and wildlife training programs; staff serving in professional leadership positions and recognized by professional organizations; presentations and publications connecting and informing the public and zoo professionals; sites with a continued Zoo presence.

Strengthened Staff and Organization

1-Year Goals

Staff know core values, and mechanisms establish their practice; organizational structures, management systems, and processes encourage cooperative work ethic; clear, efficient human resource procedures take advantage of current technologies and best practices.

5-Year Goals

Effective managers; core values practiced and reinforced; well-trained staff with resources to grow in current positions and participate in professional development activities; efficient administrative procedures; increased staff diversity through expanded recruitment and targeted outreach programs.

Performance Measures

Performance ratings completed on time; staff meeting or exceeding the standard for practicing core values; supervisors trained in administrative procedures and managing human resources and budgets; completion of professional development requirements; certificates awarded.

Renewed, State-of-the-Art Facilities

1-Year Goals

Facilities renewal plans based on sound land-use practices; infrastructure needs addressed; flexibility allowed for future growth.

5-Year Goals

Facilities renewed, based on sound land-use practices; environmentally sound, state-of-the-art design principles, materials, and technologies incorporated for renewed facilities; physical structures well maintained and visually appealing; maintenance tasks identified, prioritized, scheduled, and completed in a timely fashion; shops and operations support Zoo functions; operations evaluated and use environmentally sound practices; visitor amenities significantly enhanced and increased.

Performance Measures

Visitor amenity improvements; work orders completed; revitalized buildings or projects; significant problems identified and solutions found.

Bruce Coleman Inc./J.C. Carton

Unlike some ancient ground-dwelling sloths, which could grow as large as elephants, modern sloths are arboreal and usually weigh less than 18 pounds. Their bodies and behaviors are adapted to an upside-down lifestyle.

BY MELISSA STEWART

AT THE ZOO:

SLOW & STEADY SLOTHS

In the midst of the Smithsonian National Zoo's Amazonia exhibit, a mammal as large as a raccoon but only half as heavy hangs upside down from a slender tree branch. Hour after hour, the shaggy-coated creature remains silent and still. It is a sloth—the slowest mammal on Earth.

This 40-year-old female is one of three Linné's two-toed sloths (*Choloepus didactylus*) now living at the Zoo, but since 1950, a total of 18 sloths have called the Zoo home. Although these animals are not currently being bred or studied, past research conducted by Zoo scientists has contributed significantly to our understanding of sloth behavior and taxonomy.

Along with anteaters and armadillos, sloths are members of the order Xenarthra—a group of mammals that appeared roughly 60 million years ago. The earliest xenarthrans were arboreal herbivores with simple, stubby teeth, small brains, fused pelvises, and sturdy spines.

About 35 million years ago in South America, a few cat-sized xenarthrans began to live on the ground. No longer confined to trees, they increased in size, expanded their range in parts of South, Central, and North America, and diversified into several dozen species of tree and ground sloths.

During intermittent glacial periods between 1.8 million and 12,000 years ago, several giant ground sloth species traveled north from South America into Central and North America, crossing a land bridge that formed at the Isthmus of Panama.

Four oxen-sized species migrated as far north as the southern United States, but they became extinct about 10,000 years ago, leaving behind the five species that now inhabit the tropical forest canopies of Central and South America.

Scientists divide modern sloths into two families based on the number of toes on their front feet. Linné's two-toed sloths and Hoffman's two-toed sloths (*Choloepus hoffmanni*) are larger than their three-toed cousins. They also have bigger eyes and longer hair, and their front and back legs are more equal in length. Pale-faced three-toed sloths (*Bradypus tridactylus*), brown-throated three-toed sloths (*Bradypus variegates*), and maned three-toed sloths (*Bradypus torquatus*) have small tails and extra neck vertebrae, allowing them to twist their heads farther to the right and left than any other mammal.

Whether they have two toes or three, all sloths spend most of the day asleep, curled up in a tree notch or hanging from a branch with all four legs close together and their heads tucked between their front legs. At feeding time, sloths move slowly and carefully, hand over hand through the treetops, searching for leaves, buds, fruits, and twigs. They even mate and give birth while suspended from their long, curved claws.

Why do sloths have such an unusual lifestyle? It's the strategy they evolved to survive as tree-dwelling plant eaters in a place with many predators.

Built for Hanging Around

Most domestic herbivores, such as cattle, horses, and sheep, graze all day long. Because they feed on nutrient-poor vegetation, they must eat almost constantly. Sloths are also herbivores, and their diets are also low in nutrition; but rather than munching placidly all day long, they have become masters at conserving energy.

As any athlete knows, maintaining muscle requires large quantities of food energy—far more than a sloth's vegetarian diet can provide. Because sloths are relatively inactive and spend most of their time hanging upside down, they can get by with half as much muscle mass as similar-sized mammals. As a result, they don't need to eat as much.

And because muscle is heavy, sloths weigh far less than other mammals their size. This makes it possible for them to climb on thin branches high in the tropical forest canopy, where they can more easily find food and avoid heftier predators.

Bruce Coleman Inc./J.C. Carton

Three-toed sloths have three long claws on each forefoot and hind foot that they can use to defend against predators.

Bruce Coleman Inc./R. A. Mittermeier

Scientists found that two-toed sloths eat leaves, fruits, and flowers from a variety of trees and vines, but three-toed sloths are more specialized eaters, feeding on leaves from just a few tree species.

Although a sloth has relatively less overall muscle mass than other mammals, the muscles in its shoulders, neck, and front legs are quite strong. According to David Kessler, a biologist at the Zoo, it may take as many as five people to catch the sloths in the Small Mammal House. But a sloth's back legs are so weak that it can't walk. To move across the ground, it lies on its stomach and reaches ahead for a toe-hold. Then it uses its long claws to slowly drag its body forward.

Maintaining a high body temperature also takes energy. Sloths reduce this cost by maintaining a lower average body temperature than other mammals. Dogs, cats, horses, sheep, rabbits, pigs, and cows all have average body temperatures between 100 and 103°F, but a sloth's average body temperature is 93°F.

Just as important, a sloth's body temperature fluctuates with the ambient temperature. Like snakes, frogs, and other "cold-blooded"creatures, a sloth's body temperature is highest on warm, sunny days, and lowest at night and on rainy days. Sometimes a sloth sunbathes in the morning to warm up. Then, during the hottest part of the day, it hides in the shade so it won't overheat. During a 24-hour period, a sloth's body temperature may vary as much as 10°F. If the body temperature of a person, a dog, or a cow varies just 5°F, it can be life threatening.

Slow Food

Because sloths have difficulty moving over land, they spend most of their time in the trees. They can get just about everything they need

high above the forest floor—even water, which comes from eating juicy leaves and licking up drops of morning dew. Short bursts of feeding followed by long periods of inactivity make sloths less vulnerable to large raptors such as harpy eagles (*Harpia harpyja*) and other carnivores such as ocelots (*Leopardus pardalis*). As long as sloths remain perfectly quiet and still, they're nearly impossible to detect.

At feeding time, a sloth reaches out, grabs an overhead branch with its flexible feet, and tugs until the food is within reach of its long tongue. After pulling the vegetation into its mouth, the sloth clips the leaves with its hard, tough lips and slowly grinds them with large, peg-like teeth.

In the 1970s, John Eisenberg, then head of the National Zoo's Department of Zoological Research, asked scientists at the Smithsonian Tropical Research Institute on Barro Colorado Island, Panama, to take a close look at sloths' feeding habits. The scientists found that two-toed sloths eat leaves, fruits, and flowers from a variety of trees and vines, but three-toed sloths are more specialized eaters, feeding on leaves from just a few tree species. Further studies showed that each three-toed sloth's food preferences are determined by the bacteria living in its gut. These bacteria are passed down from a sloth's mother when she shares food with her young. Because each animal has such a specific diet, three-toed sloths rarely compete with one another for food.

Bruce Coleman Inc./M. P. L. Fogden

A Hoffman's two-toed sloth mother cradles her baby in a furry embrace. Her gestation period lasted almost a full year.

A sloth digests its food just as it does everything else—very slowly. People usually digest their food in about a day, but in sloths, the process may take a month. As soon as a sloth swallows a mouthful of pulverized plants, the bacteria in its stomach and intestines begin breaking down the food. It takes many hours for the bacteria to digest the tough plant material that makes up a sloth's diet. Only then can the sloth absorb the nutrients it needs to live and grow.

During the rainy season, sloths release their waste materials in the midst of afternoon storms. It's the perfect way to avoid attracting the attention of hungry predators. But during the dry season, getting rid of wastes is a bit more difficult. A sloth stores its feces and urine for about a week. Then it slowly descends to the ground, and deposits up to two pounds of dung. That's a lot of waste for an animal that may weigh only ten pounds!

Living Coats

Even the fur of sloths is adapted to their lifestyle. Because sloths hang upside down, their stiff, wiry fur grows differently from the coats of most mammals. Horses' hair, for example, grows from the back downward toward the belly, but sloths' fur grows from the belly toward the back, so rainwater will run off. Below this tough top layer, a dense downy layer of hair provides additional protection from pesky insects.

Each of the long, coarse hairs in a sloth's shaggy coat has a deep groove in which symbiotic algae colonies grow. During rainy periods, the algae give the fur a greenish tinge that helps the sloth blend into its forest habitat and evade predators. From time to time, the sloth will lick some of the tiny organisms from its coat for a quick, nutritious meal.

Algae aren't the only living organisms on sloths' coats. More than 120 moths of the subfamily Chrysauginae have been found in one individual sloth's fur, where the moths probably eat the algae and hide from birds and other predators.

Family Tree

Most individual sloths are solitary creatures, so when a female is ready to mate, she lets out a high-pitched scream in the middle of the night to attract a mate. Within a few hours, any males in the area slowly move in her direction. If two males arrive at the same time, they each grasp a tree branch with their back legs and swing one or both front legs at one another. The males continue their upside-down wrestling match until one gives up and leaves.

During the next few hours, the victorious male mates with the female several times. Then he leaves, and the female is on her own. Most females give birth to one tiny baby about six months after conception, but female Hoffman's two-toed sloths are pregnant for almost a year.

A newborn sloth is about ten inches long and weighs about 12 ounces. For its first five to six weeks of life, the helpless baby clings tightly to the shaggy hair on its mother's belly. It spends all its time nursing and sleeping. But gradually, the baby begins to nibble on leaves, reaching for whatever vegetation is within its grasp. It is during this period that the young sloth learns to prefer certain species of trees.

As the youngster grows, it becomes increasingly independent. In some species, juveniles can fend for themselves when they are just six months old, but in others, young continue to receive maternal care for up to two years.

When a mother sloth senses that her youngster can survive on its own, she leaves it behind and heads off to another part of her home range. Then both sloths will continue to exist as their ancestors have for millions of years—silent and sedentary, living up to their name. Z

—Melissa Stewart is a freelance science writer based in Acton, Massachusetts.

THE SECRET WOLF

BY LOUISE EMMONS
with Sharon L. Deem, Melissa Rodden, and Jesús E. Maldonado

On a black humid night in the Bolivian pampa, I know from the blasting of the radio signal in my earphones that Beatriz, the radiocollared maned wolf that I am following on foot, is but a few yards away. I twist down the control knob on the receiver until I hear no sound, but I watch the frenzied jumping of the needle on the meter, and point the antenna toward where she must be standing, perhaps listening to me. I have been following her since late afternoon, before she stirred from her cool daytime den; and now it is two in the morning, and neither she nor I have rested since sundown. She is just returning from a water hole where I know she has gone to drink. I hope our automatic camera there caught her in the act, because she outpaced me when she headed for it two hours ago from four kilometers (about 2.5 miles) away, and I lost time climbing trees to capture her vanishing signal.

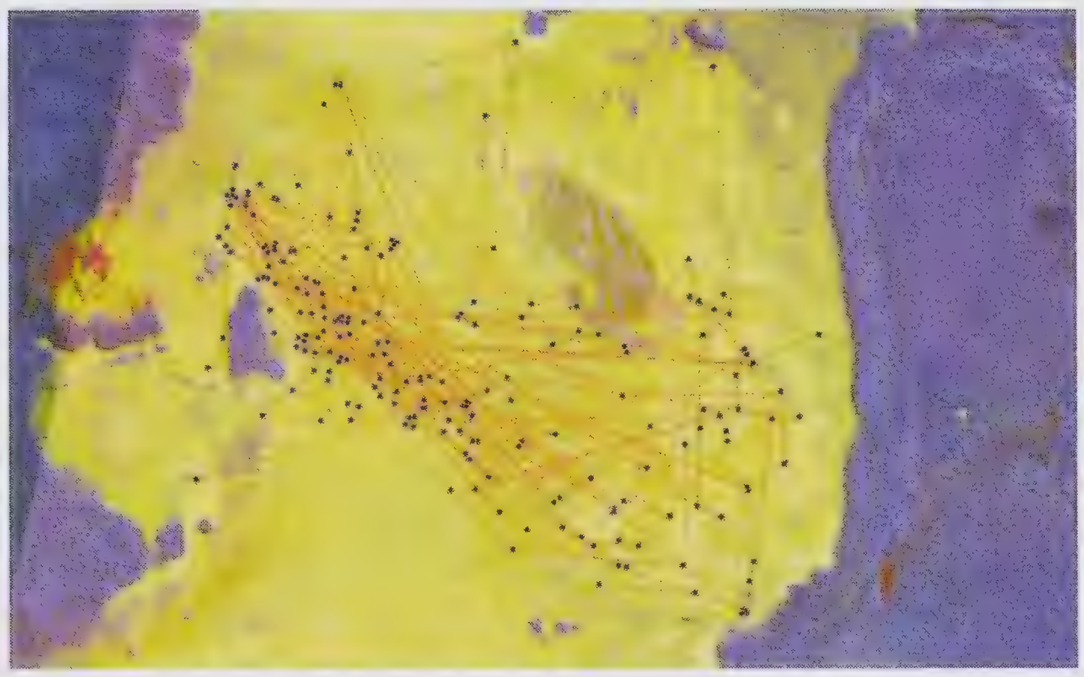
Reclusive and nocturnal, maned wolves often go unnoticed by their human neighbors, except as predators with an undeserved reputation for killing livestock. In truth, maned wolves eat only small animals such as mice and guinea pigs, fruit, and an occasional chicken.

Louise Emmons/NMNH

Louise Emmons/NMNH

Beatriz in the Bolivian pampa, where she will search the vegetation for fruit and small animals to eat. Maned wolves may have evolved exceptionally long legs to be tall enough to see over the grasses in their habitat.

Now she is on her way back. I hear nothing but chirping insects. Briefly pointing my headlight toward her, I see nothing at all. I turn off my light and stand immobile for minutes, not wanting to interfere with her behavior. Then I notice from the radio signal that she is resting (its sensor changes the signal when she moves), so I carefully sit down, drink some water, take out a tiny penlight and a book, and read for 90 minutes, thankful for rest, while she stays motionless, apparently relaxing in the bushes only a few yards away. When she starts to move again, she does so with such extreme slowness that it is a while before I am sure that she has budged. She must be hunting. She detours slowly around me, her radio signal so loud that I feel I could touch her; but I see nothing, not a glint of eyeshine nor a flash from the reflective tape on her collar, and I hear not the slightest rustle in the grass. From dusk to dawn I may not see her. If I do, she is totally casual and unafraid, walking calmly away after giving me the once-over as if saying to herself: "Oh, it's you again—have you nothing better to do than wave that antenna around?"



Louise Emmons/NMNH

This map shows Beatriz's peregrinations over a period of several months. Her radiocollar enabled Emmons to track her movements.

Maned wolf: Does the name ring a bell? How about *aguará guazú*, *lobo de crin*, *borochi*, or *lobo-guará*, as these animals are called in various parts of their wild range, or *Chrysocyon brachyurus*, as scientists dub them? If not, you join most people, even in the countries where this species lives. It seems amazing that a wolf could live among us so little noticed, especially one so striking as a maned wolf. Standing a yard at the shoulder, as tall as an Irish wolfhound, this wolf of the South American savannas is the tallest of all wild canids. Bright rusty red, with pitch-black legs, white-tipped tail, snow-white throat, and enormous, white-lined ears, a 55-pound maned wolf looks like a cross between a red fox on steroids and a big-eared kit fox, morphed upward, but not in length, and narrow as a rail. A mane of long black-tipped hair on the neck and shoulders can bristle to make the wolf look even taller. How does such a creature go unnoticed?

"Wolf" evokes images of size and power multiplied by grouping in packs to bring down large game. However, maned wolves are wolf-like in size, but foxlike in nature. They are shy and nocturnal, hunting alone for mice, guinea pigs, other small animals, and fruit. A favorite food is a tomato-like fruit called lobeira (wolf fruit). Maned wolves move with catlike stealth, at first surprising for so large an animal;

but less so when you realize that they hunt small game by pouncing on it, so they must walk softly on their giant, padded feet to catch their prey unaware. When hunting, maned wolves walk slowly, head stretched low and forward with their great ears cocked and muzzle near the ground, listening and smelling.

Despite their reclusive ways, mild manners (maned wolves don't compete with people for prey and don't kill livestock except for the odd chicken), and lack of value as tasty food or for fine fur, the species is threatened. Maned wolves' only habitat is a narrow band of South American savannas, called Cerrado or pampa, sandwiched between the southern fringe of the Amazon rainforests and the more southerly flooded landscape called Pantanal and the parched Chaco landscapes of the tropical edge. Most remaining maned wolves live in Bolivia and Brazil, with a handful persisting in Argentina and Paraguay. Peru has room for but a single pair, in the tiny remnant grassland of the Pampas del Heath, while they may be extinct in Uruguay except for an occasional wandering transient. Why are they now threatened? Our answer to this, based on more than 30 years of research, frames a conservation portrait whose model could be interchanged with other threatened species, for the same dangers are common to many animals.

Louise Emmons/NMNH

Maned wolves are the largest living carnivores endemic to the southern pampas, and after the spectacled bears of the Andes mountains, they are also the largest living carnivores endemic to South America.

Science Behind the Scenes

As they do in the wild, maned wolves have lurked behind the scenes, hidden from sight, in several Smithsonian endeavors for more than 25 years. In the late 1970s, Jim Dietz made the first, now classic, study of wild maned wolves for his doctoral thesis from Michigan State University. Dietz, now an associate professor at the University of Maryland, was the first to follow maned wolves in the wild by radiotracking. He supplemented his work on wild wolves in Brazil by watching the behavior of captive maned wolves in the tranquil Virginia countryside of the Smithsonian National Zoo's Conservation and Research Center (CRC) near Front Royal. He began this work as a postdoctoral fellow under the auspices of behavioral scientist Devra Kleiman, then a Zoo staff scientist.

Since then, students at CRC have spied on the secret lives of maned wolves from an observation tower high above a huge, isolated enclosure where maned wolves rear their pups among tall pampas grasses in a naturalistic environment. Their findings contribute to the maned wolf breeding program that began so many years ago.

Veterinarians and scientists at CRC collaborate with their counterparts at other institutions to study maned wolf behavior, health, nutrition, and reproductive physiology. To understand why these canids do not breed consistently in zoos, CRC gamete biologist Nucharin Songsasen is leading a study funded by the Morris Animal Foundation (MAF) to determine if chronic stress affects maned wolf reproduction in North and South American zoos. Songsasen is also working with scientists of the Associação Pró-Carnívoros in Brazil to determine how tourism and farming affect maned wolves living in the Brazilian Cerrado, in a study funded by MAF and the National Brazilian Environmental Agency.

Over the years, National Zoo veterinarians and scientists have learned how to keep these delicate creatures healthy, breeding, and rearing their own pups. Their expertise helps zoos around the world keep healthy populations of maned wolves. Melissa Rodden of CRC coordinates the American Zoo Association's Species Survival Plan (SSP) for maned wolves, a program to cooperatively manage captive breeding efforts by a consortium of zoos, and she recently co-edited the maned wolf account for the World Conservation Union's Canid Action Plan.

In a lab at the Zoo, the team of researchers in the Smithsonian's National Museum of Natural History Genetics Program is also hidden from public view like a rare species. The evolutionary biologists there are on the forefront of endangered species conservation research, with projects on elephants, black-footed ferrets, Indian wolves, kit foxes, Hawaiian birds, and avian malaria, to mention just a few. Senior scientist Jesús E. Maldonado is an expert on canid genetics, with a library of genetic information that can be used to quickly reference and examine DNA from almost all the wild dog species of the Americas. Rosário Franco, a master's degree student from Uruguay, came to the Zoo to work under Jesús on a study of the genetic diversity of maned wolves, and their project quickly joined up with mine.

My own maned wolf studies began in 1998, when I went to Bolivia to study the mammal community in remote Noël Kempff National Park (NKNP) on the southern boundary of the Amazon rainforest, just where the habitat switches from humid forest to dry

forest and savanna. After a career working deep in equatorial forests, I wanted to find out what mammal communities are like at their environmental limits, where two major biomes come together, and where a small change in climate can transform the entire ecosystem from rainforest to savanna or vice versa. There in the savanna, I became entranced by maned wolves and could not resist adding them to my project, a study of the biodiversity of the park, which is in collaboration with the Museo Noël Kempff Mercado of the Universidad Agraria "Gabriel René Moreno" of Santa Cruz. Students from the Museo help conduct field surveys and radiotracking of wolves as an essential part of the project.

Maned wolves are the largest living carnivores endemic to the southern pampas, and after the spectacled bears of the Andes mountains, they are also the largest living carnivores endemic to South America. They are the odd man out among members of the dog family, for according to recent theory, they are way too big for the lifestyle they live. Canids of this size are supposed to be meat-eaters that hunt big game, yet they do not. To me this suggests that the theory, not the animal, is at odds with nature, and leaves a question to be solved about how this eccentric fox-wolf manages to live on its diet of small animals and fruit. Answering this question is one major focus of my research. But the globally threatened status of the maned wolf brought conservation to the fore, and eventually created an urgent need for a multidisciplinary approach to maned wolf conservation. This is what brought so many Smithsonian scientists together.

Louise Emmons/NMNH

Each breeding wolf lives monogamously with its lifelong mate, and the pair shares a mutual territory.

Bad Luck Wolves

The tale of why maned wolves are in trouble is a mini-lesson in conservation biology. The first bad roll of the dice is maned wolves' restricted distribution in a small number of grassland habitat types; and the dice are loaded against them, because another species finds the same habitats perfect for its own uses—*Homo sapiens*. Worldwide, the natural savannas that border temperate or equatorial forests have been the areas first and most profitably exploited for cattle grazing. The temperate grasslands of Argentina and Uruguay were the first parts of South America to be almost totally converted to cattle ranching, and more recently, to industrial grain production. The natural savannas of Brazil and Bolivia have grazed cattle for more than two centuries, but in only the past decade, millions of acres of both Cerrado and dry forests were irreversibly swept by bulldozers, burned, ploughed, and converted to chemical-intensive soybean, cotton, wheat, maize, and oilseed monocultures. Well-managed cattle ranching on natural grasslands is not incompatible with maned wolf survival—most maned wolves now share their habitat with cattle, as do many other native species of mammals and birds. But a monoculture field of soybeans or cotton is worse than a desert: Nothing of the native community of fauna or flora survives there.

The second bad toss for the wolves is the combination of their XXL size and their social behavior. Large size itself is not a handicap to species survival. Just the opposite can be true, as large species usually have large geographic ranges; pumas, which range through large parts of the Americas, are a good example. But for maned wolves, large size is directly linked with being naturally, without any other problem, very rare. Maned wolves may walk alone, but they are not solitary. Each breeding wolf lives monogamously with its lifelong mate, and the pair shares a mutual territory. Some overlap can occur with neighbors, but for the most part, each pair and its young occupy by themselves an area of 25 to 100 square kilometers (roughly 10 to 40 square miles). Their large body size thus translates into a need for large living space. The area of NKNP is 1.5 million hectares (about 5,800 square miles). About a third of the park's area is suitable for maned wolves, but all of that space is estimated to hold only about 120 breeding pairs. Yet a conservation biology rule of thumb is that a population of 500 individuals is needed for long-term sustainability.

In the Genes

Most of us know that inbreeding is a bad idea, and conversely, that hybrid vigor can produce exceptionally resistant individuals because they are often more robust in physiology and other areas. The wide array of genes in living organisms acts like a heritable baggage of contingency plans. If a disease epidemic devastates a population, there are usually at least some survivors, because some individuals happen to possess genes that make them less susceptible to the disease. A different disease will pass over those with a different set of genes. Similarly, if famine strikes, only those with genetically low metabolic rates may survive, while in good times, skinny folks may have an advantage. If members of a population are all genetically identical as a result of excessive inbreeding, all could be swept away by a single surprise event. Nature is intrinsically unpredictable and often inhospitable, and exerts a mindless triage on every organism. The best insurance for a species' long-term survival in the face of an unpredictable Nature is to have a big population of individuals that carry a big population of different variants of genes; in other words, a population with high genetic diversity. This makes a species more likely not only to resist disease or deleterious genetic mutations, but also to be able to adapt to changes in habitat or climate. The more individuals there are, the more probable it is that some will escape a natural disaster.

Louise Emmons/NMNH

The author, Louise Emmons, examines a tranquilized maned wolf in Bolivia.

Knowing something about a species' genetic diversity is thus a key to predicting its long-term prospects. I have been working with Jesús Maldonado and Rosário Franco to measure the genetic diversity of maned wolves at the Los Fierros study area in NKNP. We collect some DNA from blood samples taken from captured individuals, but most is gleaned from small samples cut from feces encountered on the pampa, where location of the feces is mapped by GPS. Feces include some cells (and their DNA) from the intestines of the depositor, and modern technology can isolate these from everything else that the animal ate. Our results are valuable standing alone, but Jesús and Rosario have put them into a global context by comparing the genetics of my study animals with that of maned wolves from Brazil in the CRC breeding colony, as well as of animals from Argentina. Based on these samples, we learned that maned wolves have low genetic diversity as a species, and perhaps suffered a genetic bottleneck in their past.

But the good news for the conservation of maned wolves in NKNP is that, within the small geographic area we have sampled thus far, the wolves exhibit a good amount of the variability that exists in the species. Further, Los Fierros is bordered on one side by cattle estancias, the nearest of them owned by a conservationist who prohibits hunting. Maned wolves on these estancias interbreed with the park population and thus can be included in conservation plans. As well as measuring genetic diversity for conservation predictions, we are using the DNA samples to evaluate kinship between the individuals we sample. This will help us to better understand the social structure of the population and try to answer such questions as whether neighbors are closely related and how far youngsters of each sex disperse when they leave their parents' territories.

Disease Alert

At the start of my study I was leery of anesthetizing maned wolves to capture them for radiocollaring without expert advice, so I enlisted the support of the Field Veterinary Program of the Wildlife Conservation Society, which sent wildlife veterinarian Sharon Deem to join me in Bolivia. Sharon, now part of the Zoo's Department of Animal Health, helped capture and collect health data on the first maned wolves we radiocollared. Since then, Sharon and other National Zoo vets have become important participants in the project.

Maned wolves suffer from a serious and possibly hereditary metabolic flaw, which may result in a syndrome called cystinuria, a failure of the renal system to absorb the amino acid cystine. Cystine is excreted in the wolves' urine, and may cause crystals to form in their kidneys and bladder, which can cause death from kidney

Sharon Deem/NZP

Smithsonian and National Zoo scientists, along with National Zoo veterinarians, conduct maned wolf field studies in the pampas of South America (above). They also study and observe maned wolves at the Zoo's Conservation and Research Center (below) and at the Zoo.

essie Cohen/NZP

failure or blockages in the urinary tract. Most of what is known about cystinuria in maned wolves comes from the work of Mitchell Bush, a veterinarian at CRC and a leader of the Zoo's maned wolf research, in collaboration with veterinarian Kenneth Bovee from the University of Pennsylvania. In addition, many wild wolves are infected by the giant kidney worm (*Dioctophyme renale*), a parasite introduced from the Northern Hemisphere that completely destroys the right kidney. These problems have been known for many decades, so that when the analyses of Sharon's samples from the first two animals came in, we were not surprised to find both kidney diseases in the Bolivian wolves.

We were much concerned to find that the wolves also had antibodies showing that they had been exposed to many infectious diseases common in domestic dogs, and likely introduced to South America. These included canine heartworm, distemper, parvovirus, adenovirus, and toxoplasmosis, among other, less well-known diseases—not to mention a number of intestinal parasites. A wolf caught on one of our later trips also had antibodies to rabies virus and coronavirus. This alerted us to a hidden disease threat to the survival of wild maned wolves.

In Brazil's Emas National Park, where Leandro Silveira is leading a long-term study of maned wolves, 475 kilometers (nearly 300 miles) of roads crisscross the park, and road kill by vehicles is a major cause of mortality in maned wolves.

To determine whether a species is threatened, and, if it is, whether we can improve its future prospects, we need to know what individuals die of, and whether the population is stable or decreasing. Discovering what maned wolves die from is not easy—they live out of sight in a climate where dead bodies are skeletonized by scavengers, and the bones are dispersed within a few days. In Brazil's Emas National Park, where Leandro Silveira is leading a long-term study of maned wolves, 475 kilometers (nearly 300 miles) of roads crisscross the park, and road kill by vehicles is a major cause of mortality in maned wolves. In contrast, NKNP is nearly roadless, so vehicles are no threat. We are usually able to identify sources of mortality only indirectly, largely by recording the presence and subsequent disappearance of individual animals in photos taken by camera trapping. But we did learn that one collared maned wolf at a different site in the park died at the same time as we noted a drastic drop in numbers of foxes, suggesting that a canine disease epidemic may have hit the area. Another maned wolf died of old age. In the future, we plan to extend our veterinary studies to include wild foxes in the park and domestic dogs in bordering communities, to see whether we can help secure the future of wild carnivores by improving the health of dogs in the surrounding areas. Studies of maned wolves' response to canine diseases in captivity at CRC and elsewhere will help us understand what diseases threaten wild wolves, and how best to manage parks to help ensure a long future for wild carnivores.

As parks become isolated islands of natural habitat in seas of human-dominated landscapes, it becomes more and more necessary to actively and proactively manage them to optimize ecosystem or species survival. Management can take many forms: monitoring of populations to make sure they are healthy; burning of grasslands or naturally fire-adapted forests to maintain the habitat; preventing fire in non-fire-adapted forests; augmenting water sources or maintaining wetlands; controlling pollution; removing introduced species; and trying to prevent the introduction of exotic diseases. And all such management activities involve education and participation of people in local communities. With Fundación Amigos de la Naturaleza, the Bolivian non-governmental organization that supports scientific studies in the park, I am helping to design the management plan for maned wolves. This plan will be the result not only of our field studies, but equally of the critical knowledge provided by the other Smithsonian scientists.

People living near the Zoo, along Rock Creek Park, and in Cleveland Park and Adams Morgan may sometimes hear strange, deep, resonant barks in the nighttime since maned wolves went on exhibit at the Zoo in August. We hope that, like giant pandas have done for the conservation of wilderness areas in China, these skinny giants' appeal to the public will lead to better conservation of the southern pampas, maned wolves, and all pampas wildlife. And while maned wolves are reclusive near-ghosts in the wild, as I learned when I radiotracked them on foot, the maned wolves at the Zoo are there for people to see.

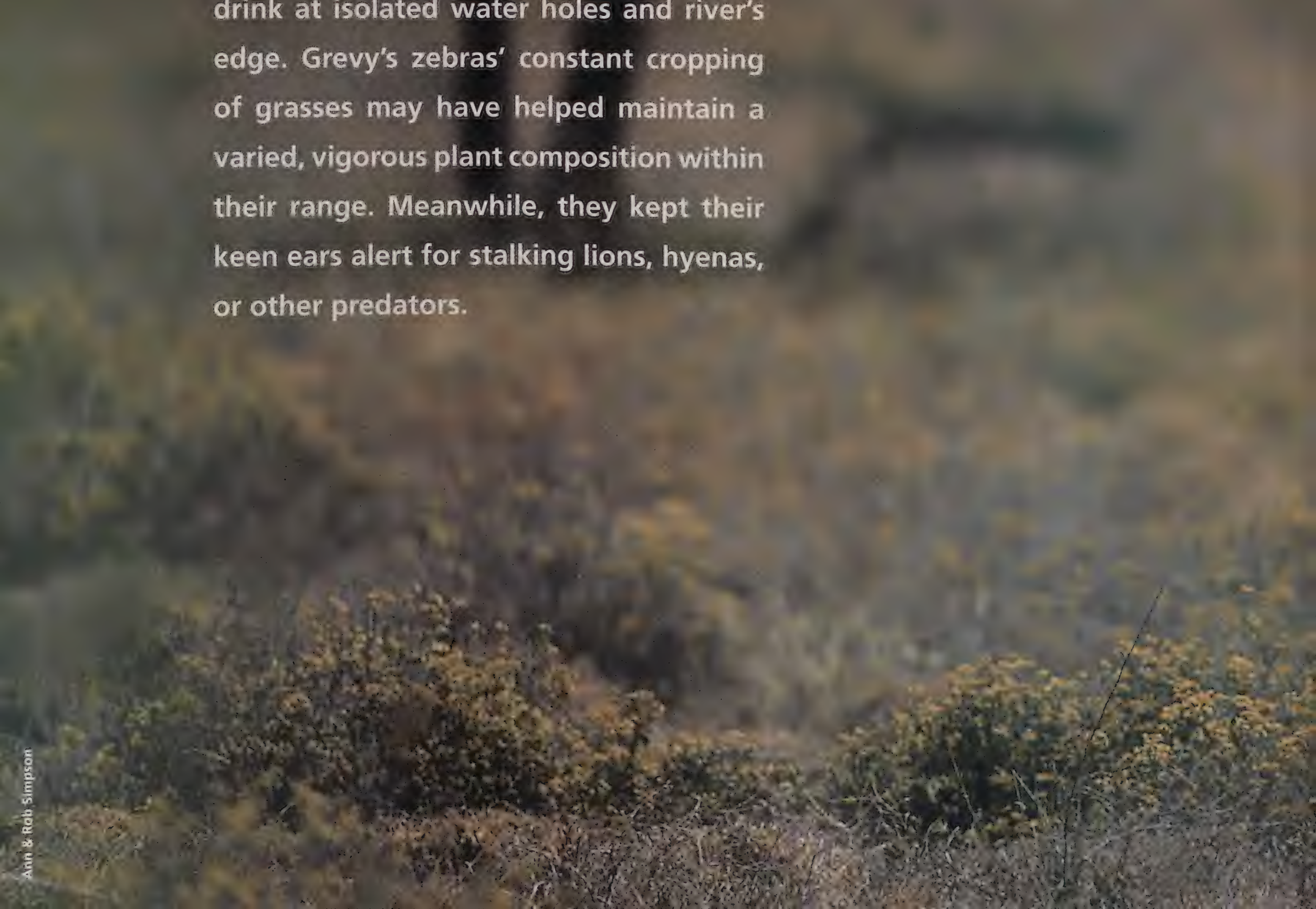
These days, thanks to our generous project supporters at the National Geographic Society and the Wildlife Conservation Society, we have upgraded to the latest technology and now equip the maned wolves we catch with GPS collars that automatically track their movements and store the data in a memory card. We still do some tracking on foot, to make sure that we know their home areas, and to check that they are well, but the GPS collars do a much better job of following than we can. But I confess that I often miss the long nights alone with the wolves in the pampa, listening for a distant bark or glimpsing a pair of green-white eyes moving through the long grass. Z

—Louise Emmons is a research associate at the National Museum of Natural History; Sharon L. Deem is a veterinarian at the National Zoo; Melissa Rodden is a computer specialist at the Zoo's Conservation and Research Center; and Jesús E. Maldonado is a research geneticist with the National Museum of Natural History's Genetics Program.

Thin Stripes on a Thin Line

BY HOWARD YOUTH

Not very long ago, the Grevy's zebra thrived in semi-deserts from present-day Eritrea to western Somalia, and south well into Kenya. There, this striped member of the zebra, ass, and horse family Equidae grazed on tough grasses and traversed acacia- and scrub-peppered plains to drink at isolated water holes and river's edge. Grevy's zebras' constant cropping of grasses may have helped maintain a varied, vigorous plant composition within their range. Meanwhile, they kept their keen ears alert for stalking lions, hyenas, or other predators.



Ann & Rob Simpson

A Grevy's zebra at Buffalo Springs Game Reserve in Kenya, one of the few places where this endangered species is protected from hunters, cattle, and other threats.

This was, more or less, a snapshot of the Grevy's zebra in its habitat well into the 20th century. Then along came guns and increasingly large cattle herds. Overgrazing by cattle, excessive hunting, and restricted access to dwindling water supplies have reduced or extirpated the Grevy's zebra (*Equus grevyi*) from most of its former range, moving it toward the brink of extinction. The zebra's predators also vanished from many areas after being poisoned or shot by herders and ranchers. Today, the ecological footprint of humans and cattle presses far more firmly on the land than that of the zebras. Most Grevy's zebra populations continue to drop, echoing the failing health of the fragile ecosystem upon which they depend.

The World Conservation Union (IUCN) classifies the Grevy's zebra as endangered. In a 2002 "Status and Action Plan for the Grevy's Zebra" created by the IUCN's Species Survival Commission (SSC), biologist Stuart Williams wrote, "In recent history, Grevy's zebra has undergone one of the most substantial reductions of range of any African mammal." The zebra's decline has been swift: In the late 1970s, biologists estimated that 15,000 remained. Today, roughly 2,000 wild individuals remain in Kenya and between 120 and 250 more live in three isolated Ethiopian populations, survivors of an approximately 80 percent drop in numbers.

The Other Zebra

Grevy's zebra was named for Jules Grévy, a former president of France who received one of the animals from Menelik II, king of Shoa and emperor of Abyssinia, in 1882. Today, Grevy's zebras can be seen at the Smithsonian's National Zoo and at many other zoos around the world. They are larger, with more bristly, erect manes, bigger ears, and narrower stripes than the world's two other zebras—the plains or common zebra (*Equus burchelli*), and the mountain zebra (*Equus zebra*) of southern Africa.

In recent history, Grevy's zebra has undergone one of the most substantial reductions of range of any African mammal.

Grevy's zebra also differs in its habits and habitat, and these two factors are likely connected. The plains zebra thrives in seasonally lush savannas, where males live with and protect harem groups of two to five females and their shared offspring. In their more arid semi-desert habitat, Grevy's zebras, like the African wild ass (*Equus africanus*), have no permanent social ties outside of the bond between mothers and their offspring. Males hold large territories, through which females drift. Other males are tolerated as well, as long as they do not try to mate with females within another male's territory. Many experts believe that this flexibility allows Grevy's zebras to seek out as many feeding possibilities as they can in their habitat, and quickly breed during brief windows when both ample water and grazing are available.

Females can give birth to single foals once every two years. In times of hardship or inadequate food or water, this interval can slip to once every three years. Youngsters generally stay with their mothers for two to three years before striking out on their own.

Grevy's zebras often associate with other ungulates, which may give them a leg up on predators. For example, they sometimes graze and travel with wildebeest (*Connochaetes taurinus*), beisa oryx (*Oryx gazella beisa*), eland (*Taurotragus oryx*), and plains zebras when their ranges overlap. Although primarily grazers, Grevy's zebras also browse forbs, shrubs, and trees when grasses are scarce.

Large cattle herds may denude the zebra's habitat. Once cows chew plants to the ground, the highly erosive soil and fragile vegetation take far longer to recover than they would in more lush savanna lands where plains zebras generally roam. Prime feeding grounds for Grevy's zebras are now a rare commodity. "The only areas that remain in 'good' condition are those that are too far from water to be used by livestock or those that were under-used due to continued security threats," writes Williams in the IUCN/SSC's action plan. In most other areas, Grevy's zebras take a backseat to cattle. "As long as pastoral people maintain high grazing pressures in the areas used by them," Williams writes, "it is likely that Grevy's zebra will become increasingly mobile, moving from area to area in search of sufficient food resources."

Another necessity is water. Grevy's zebras pin their survival and reproductive success on it. This vital commodity, however, keeps slipping farther and farther from the animals' reach due to human activities. In their moisture-starved habitat, the zebras must be within fairly easy reach of water holes or rivers. Rains flush these water sources but also transform the land around them. In a case of "just add water," rains turn dusty plains into fertile pastures, increase the animals' access to drinking water—and bring on a peak in Grevy's zebra breeding. In prolonged dry conditions, there is less breeding because females go out of estrus as their bodies adjust more to a state of survival than one of readiness to mate.

Grevy's zebras are adapted to semi-desert and can go without water for two to five days, although they will drink daily if water is available. Lactating females, however, need water every day or two. Females with young stay fairly close to permanent water sources and groups of mothers with foals often travel together.

The zebras prefer to drink at midday, when it is easier to spot lurking dangers. Where cattle keep them from water, Grevy's zebras often drink at night, after herders and their livestock leave. This change in schedule may increase the danger of attack by predators.

Intensive irrigation has dried up many traditional zebra water sources downstream from farm areas. The result has been a dramatic shriveling of the Grevy's zebra's range and population. In addition, herders sometimes block the animals' access to water by fencing water sources with thorn-covered acacia limbs. In many areas where they once abounded, Grevy's zebras, if they appear, seem like distant apparitions—keeping far from people and their cattle.

One reason many Grevy's zebras are skittish is that they are no

Gerald & Buff Corsi/California Academy of Sciences

Females with young must stick close to reliable water sources, but they are increasingly forced to compete with livestock and tourists for a spot at water holes. They are also less likely to breed and produce offspring when they go without water for long periods.

strangers to gunfire. Through much of the 20th century, hunters shot them for their dazzling pelts, which often found their way into fashionable shops in North America and Europe. In the 1970s, trade in Grevy's zebra skin and parts was curtailed under CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora. In addition, the Kenyan and Ethiopian governments have declared the animal a protected species for more than 20 years. Despite the laws, these large, thin-striped equids still wind up in hunters' sights as food and may be used in traditional medicine.

"The greatest threat to Grevy's zebra in Ethiopia is the prevalence of Kalashnikovs (also known as AK47s) in most areas where they are found," says Alastair Nelson, a biologist who participated in a 2003 survey of Ethiopia's Grevy's zebras. "Beyond this, the [human] population pressure in Ethiopia is reducing habitat available to them, and there is considerable environmental degradation as a result of sustained overgrazing by domestic livestock."

To the south, in Kenyan reserves such as Samburu, Grevy's zebras drink and feed in some of the few refuges free of cattle hordes and guns, but these protected areas can meet their needs for only part of the year. Even in protected areas, the animals are sometimes under stress. Tour vehicle drivers in Kenyan reserves often ignore the rules and stray from the roads, disturbing zebras and other wildlife, causing erosion, and destroying fragile vegetation. And tourists using water holes for swimming may keep day-drinking zebras from vital water sources.

A Brighter Future?

Despite the grim situation, there is much hope for Grevy's zebras if conservationists can stall the steep decline in their population. In recent years, conservation efforts have begun to focus on local communities—the people who share the landscape with these animals. In January 2003, Fanuel Kebede, a research biologist with the Ethiopian Wildlife Conservation Organization whose work is supported by the U.S.-based Wildlife Trust, convened a workshop on the conservation of Grevy's zebra and the critically endangered African wild ass. The workshop was conducted in the Afar region of Ethiopia, where populations of both species live. It brought together biologists, regional and federal government leaders, local elders, and game scouts. "Having the communities support research and conservation is critical," says Patricia Moehlman, an equid biologist who works with Kebede. "The Ethiopian elders were supportive of the conservation of Grevy's zebra and the African wild ass but it will take a long-term commitment by everyone," says Moehlman.

The picture is most bright at the southern end of the zebra's range in central Kenya. There, a robust, well-studied population of about 1,000 Grevy's zebras moves through three game reserves—Buffalo

The National Zoo's two Grevy's zebras are on exhibit at the Cheetah Conservation Station.

Jessie Cohen/NZP

Springs, Samburu, and Shaba. But even this large population is declining. While there are usually Grevy's zebras in these parks, they frequently come and go, spending much of their time on unprotected lands. According to the IUCN/SSC action plan, less than 0.5 percent of Grevy's zebras' range falls within protected areas. While outside the parks, the zebras compete with cattle herds for limited water. Likely as a result, this population, like most others, is highly mobile, has a low juvenile survival rate, and is in steady decline. "Foal survival has been directly related to the extent to which their mothers move," reads the action plan. "There is low foal survival when mares make large or frequent small-scale movements," as many must do when their water sources become more difficult to visit or locate.

Not all private lands, however, prove to be poor feeding and breeding areas. Grevy's zebras thrive on the nearby Lewa Plateau, an area once considered marginal habitat for them. There, the Lewa Wildlife Conservancy—a private conservation organization run from a cattle ranch-turned-wildlife sanctuary—works with local communities and Saint Louis Zoo and Princeton University biologists to save Grevy's zebras and other wildlife.

On the Lewa Plateau, local ranchers now have a growing appreciation for the Grevy's zebra's place in the ecosystem, as well as its appeal to tourists. On a number of large holdings, ranchers removed fences to increase the animals' access to grazing and water. Some also periodically burn savannas to improve the quantity and quality of grassland. In addition, the habitat managed by conservancy members may now be better for Grevy's zebras because elephant, giraffe, and other large browsing animal populations are healthy. These browsers clip back the bush cover, encouraging increased grass growth and thus greener pastures for zebras.

Today, this area is one of only a few that support a healthy Grevy's zebra population. About 420 live there, and Lewa is now considered an important birthing area and a source area for the populations that have been sinking nearby.

The plains zebra traditionally reigned supreme on the Lewa and biologists are studying to what extent the two zebras now compete against one another. "We found that habitat preferences of the two species were similar but not identical. Largely, they share most of the habitat and spend most of their time together," says Dan Rubenstein, professor and chair of the Department of Ecology and Evolutionary Biology and director of the Program in African Studies at Princeton University. Rubenstein and his colleagues have dedicated much of their time in recent years to learning more about Grevy's zebra biology, while working to build bridges between communities and conservation programs.

Differences in behavior sometimes set the two species apart. Grevy's zebras without young in tow move farther from water than plains zebras ever do. "This provides [Grevy's zebras] with a spatial refuge, which reduces competition to some degree, but the real impact of competition is best measured by changes in feeding rate," says Rubenstein. While 420 Grevy's zebras inhabit Lewa lands, they share the acreage with about 1,200 plains zebras.

After studying the feeding rate of both species on a local level, Rubenstein and his colleagues believe that the presence of many plains zebras harms Grevy's zebras. "The bottom line is that plains zebras disproportionately consume vegetation when they locally outnumber Grevy's zebras. We think Grevy's zebras then lose condition, which compromises their health and makes it harder for them to rear offspring." Lewa now holds about 20 percent of the world population of Grevy's zebras and Rubenstein and others are considering ways that managing plains zebra numbers might help keep the area's Grevy's population afloat.

> According to the IUCN/SSC action plan, less than 0.5 percent of Grevy's zebras' range falls within protected areas.

But there is another problem. "Grevy's zebras represent a disproportionate share of the diet of lions on Lewa," says Rubenstein. He and his colleagues Kenyan biologists David Njonjo and Belinda Low studied hairs collected from dried lion dung and found two results: Zebras constitute about 70 percent of the diet of Lewa lions, and Grevy's zebras make up about 55 percent of the zebras killed.

If plains zebras far outnumber Grevy's zebras, why does the less common species more often wind up a meal for a hungry lion? Rubenstein hypothesizes that it's basic behavior that makes the difference. While plains zebra females always travel with males that kick at attacking lions, Grevy's zebra males patrol large territories, leaving females to fend for themselves. In arid areas to the north where Grevy's zebras once flourished, lion densities were traditionally low, so the temporary absence of males was not such a problem.

Rubenstein and his colleagues collaborate with local data-gatherers thanks to a Saint Louis Zoo-funded scout program that employs nine people in the Samburu pastoral communities of Nagroni, Naibelibeli, and Serolipi. "Scouts go out and do what they normally do: Women collect wood and water, men herd livestock," says Rubenstein. But scouts also carry with them field checklists and GPS units. When they spot Grevy's zebras, they note details such as location, weather, features of the habitat and landscape, behavior, and interactions between livestock and wildlife. "These are data we can't gather while driving around in a Land Rover, especially in the woodlands," Rubenstein says. "What has emerged from their data is unbelievably interesting. For example, we have learned that herds get larger during the day, a pattern that is unique to landscapes they share with livestock."

"This year," says Rubenstein, "we took the data back to the community." Biologists met with local elders and prepared cartoons to illustrate the results of statistical analyses of zebra behavior and

conservation needs. Chiefs translated Swahili and English into the local Samburu language. "When we asked the local people why they thought Grevy's herds were larger from 3 p.m. to 7 p.m., there were chuckles," says Rubenstein. "Some people said, 'Maybe they're waiting for us to go home.' The villagers realized that their cows are all over the best grasslands until nightfall and that this might have an impact on the zebras. This kind of presentation leads to fruitful discussions."

Much fieldwork remains to be done before scientists can clearly understand Grevy's zebra ecology and distribution. This proves very difficult in areas racked by political or tribal violence, and where gun-shy zebras do their best to keep out of sight. So far, most of the behavioral studies focused on Grevy's zebras have taken place in the semi-arid lands of Kenya. Scientists still do not know if the zebras exhibit regional differences in behavior or if other aspects of the populations vary. Also, no one currently knows if the scattered populations have genetic differences, although Rubenstein and his colleagues, with the support of the National Science Foundation, are extracting DNA from the dung of Grevy's zebras to determine if certain fragmented populations show genetic subdivision. In Ethiopia, Kebede has collected Grevy's zebra fecal samples in the northernmost, isolated Alledeghi population, which will add a new dimension to these analyses.

Frederick Douglas Atwood

Zebras constitute about 70 percent of the diet of Lewa lions, and Grevy's zebras make up about 55 percent of the zebras killed.

Just knowing how many zebras remain has been a challenge. Since 1978, surveys have been done in different ways and in different seasons. "It's not entirely clear how much the animals living along the Ethiopia-Kenya border move," says Moehlman. For example, the population found in Chew Bahir in southwestern Ethiopia may cross into Kenya. "The question in my mind is are they moving down into Kenya and hence not counted? Just about every time a survey's been done, it's been done a different way. Surveys need to be done regularly and with the same methodology. We also need to count Grevy's zebra in southern Ethiopia and northern Kenya at the same time."

There have been intriguing reports of Grevy's zebras in a fourth location in Ethiopia as well as in southern Sudan, where a pilot named Charley Trout saw some while he was flying in relief supplies in the 1990s. These animals may represent new and unknown populations, so biologists like Moehlman are keen to find ways to assess their numbers and conservation status.

Zoos play vital roles in educating people about the plight of Grevy's zebras. They provide opportunities for people to observe these animals firsthand and to learn about their situation in the wild. Some zoo programs support research that engages local communities and answers some of the many questions remaining about this rare zebra's natural history. The Grevy's zebra population in North American zoos is managed by a Species Survival Program (SSP) under the auspices of the American Zoo and Aquarium Association. The National Zoo's role in the SSP is to serve as a holding facility, where young males live until the SSP recommends that they go to another zoo for breeding. SSP management helps ensure that the zoo population does not lose genetic diversity. The maintenance of genetic diversity in zoo Grevy's zebras is an important safeguard for wild populations, although the reintroduction of zoo-bred animals is not currently being considered as a conservation action.

For now, conservationists hold out hope for remaining wild populations. "As long as there are refuges where Grevy's zebras are highly valued," says Rubenstein, "there will always be some. But if we really want to boost populations we have to find ways for the economic development of local people to go hand in hand with Grevy's zebra conservation. The local pastoral people's wealth is in their herds. If Grevy's zebras also have value to them, then maybe we can turn the corner."

Moehlman agrees. "The future viability of Grevy's zebra populations is absolutely dependent on local [human] populations. You have a complicated set of factors, including a semi-arid habitat where people are struggling to survive. Community-based conservation, good research, and the commitment to the local communities involved benefits not only the Grevy's zebra but the whole ecosystem." Z

—Contributing editor Howard Youth first saw Grevy's zebras feeding with beisa oryx ten years ago, during a FONZ tour that visited Kenya's Samburu Game Reserve.

Books, Naturally

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The Wild Parrots of Telegraph Hill: A Love Story . . . with Wings

Mark Bittner. 2004. Harmony Books, New York. 304 pp., hardbound. $22.

Elsewhere in the Land of Parrots. Jim Paul. 2003. Harcourt, Inc., Orlando, Florida. 305 pp., softbound. $13.

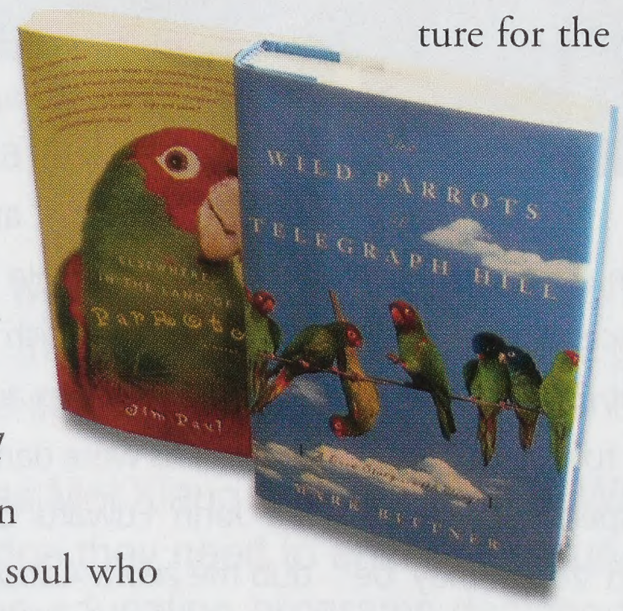
The United States' only native parrots—the Carolina parakeet and the thick-billed parrot—were shot into oblivion nearly a century ago. As if unwittingly to make up for it, people have helped several exotic parrot species to colonize the once parrotless urban frontier.

Parrots of all kinds are immensely popular as pets, and hundreds of thousands of wild-caught parrots of many different species were imported into the U.S. from about the 1960s until the trade was banned in 1993. Inevitably, many of these beautiful creatures escaped captivity or were released when their captors tired of them. Against all odds, some of the liberated birds found others of their kind, and once again colorful wild parrot flocks were brightening the sky and adding their raucous squawks to the soundscape, primarily in human-dominated urban and suburban habitats.

The monk parakeet is among the most successful, with thriving colonies in 12 states and in such unlikely spots as Chicago, Brooklyn, and Montreal. California is home to as many as ten breeding parrot species, and Florida boasts—if that is the right word—individuals of about 70 parrot species (out of a total of about 330 living parrot species), although most of these are not established breeding populations. Native to small parts of Ecuador and Peru, the red-masked parakeet, also known as the cherry-headed conure, now lives and breeds in both Florida and California, where San Francisco's population in particular has become the poster flock of the exotic parrot set as a result of the publication of *The Wild Parrots of Telegraph Hill: A Love Story . . . with Wings* and *Elsewhere in the Land of Parrots.*

Both are delightful, wonderfully written stories—one fact, one fiction—about the transforming power of the wild. (And it would be a miracle if the fiction were not inspired by the fact.) At age 42, Mark Bittner was leading an aimless solitary life in San Francisco while still trying to find himself—in his words, he was a "dharma bum." Then he lucked into a live-in housekeeping job on Telegraph Hill, where he discovered the parrots while idly bird-watching from his porch, and got hooked on them.

For the next three years he immersed himself in the lives of these birds, getting to know each and every one as an individual with a distinctive "personality." He carefully documented the relationships within the flock, tracked which pairs produced young, and came to understand the birds' behavior so well it was as if he were part of the flock—which in some ways he was. Eventually, he and his birds attracted the attention of the media and of a filmmaker, with whom he fell in love. As the book ends, the couple had purchased a home on Telegraph Hill, from which he continues to look after the parrots, albeit with less intensity. Finally, he's found himself, in a flock of wild urban birds.



In *Elsewhere in the Land of Parrots,* David Huntington is a somewhat similarly lost soul who fears the outdoors and spends his days writing deliberately meaningless poetry. Then his father gives him a red-masked parakeet. However, Little Wittgenstein, as David names his unwanted pet, so terrorizes him that he pitches the bird out the window of his San Francisco apartment. Remorse finally forces him to brave venturing into the urban wilderness—and beyond.

His search for Little Wittgenstein leads him to Telegraph Hill, where he meets a Bittner-type character and actually sees his former pet flying with the flock. David then determines to visit the natural habitat of red-masked parakeets. In Ecuador, he meets an American woman who is having her own adventure trying to study the rare parakeets in the wild. Naturally, they fall in love and end up living—where else?—on Telegraph Hill, where, like David, Little Wittgenstein "was now living in the larger world, part of a family, a regular member of society."

When Bittner started watching the San Francisco flock of red-masked parakeets in 1990, there were 26; today, according to his website, there are about 130. In Ecuador and Peru today, where they were once the commonest of parrots, flying in flocks of thousands, it is rare to see a flock as large as San Francisco's. Habitat loss and relentless capture for the pet trade have taken a huge toll on the species.

There are many sound reasons for discouraging alien exotic species from taking up permanent residence here. But perhaps because these beautiful birds are disappearing from their natural habitat, it is very difficult not to cheer about parrots once again flying wild in the United States, eating the fruit of the exotic trees we've planted, and being eaten in turn by exotic cats and native hawks—all on the wild streets of San Francisco.

—*Susan Lumpkin*

BioAlmanac

by Emily Huhn

Luring Dinner with Dung

Burrowing owls (*Athene cunicularia*) keep house by spreading mammal dung on their doorsteps. Then, they sit and wait for dinner to arrive, making a quick meal of any dung beetles attracted by the alluring scent.

It was once thought that the owls used the dung to hide the scent of their eggs from predators, but recent experiments disproved this theory. Scientists at the University of Florida conducted a new study and found that the owls use the dung as a tool to lure prey, with great success: Owls with dung-strewn burrows ate ten times more dung beetles and six times more dung beetle species than owls with dung-less burrows. The study, published in the September 2 issue of *Nature*, adds to a growing body of evidence that wild animals use tools.

What's in a Name?

Europeans first saw Grevy's zebras in the Roman colosseum, where they were called *hippotigris* (*hippo* is from the Greek for horse and *tigris* refers to tiger-like stripes). Subsequently, they were lost from European view until 1882, when the emperor of Abyssinia sent a live one to the then-president of France, Jules Grévy. The animal died on arrival, however, and was stuffed and displayed in the Paris natural history museum. Based on its skin, a French scientist declared it a new species and named it *Equus grevyi* in Grévy's honor. *Equus* is Latin for horse, and is the genus name of all living species of horses, zebras, and asses. The word zebra may be derived from *zecora*, these animals' name in Galla, a language of Ethiopia, or from the Congolese word *zebra*.

Another species of zebra, Burchell's (or plains) zebra—*Equus burchelli*—was named for its British discoverer, William John Burchell. Little known today, Burchell was a great explorer of Africa. He spent five years (1810-1815) in southern Africa during which he traveled more than 4,300 miles. He described many new species, including white rhinos, and collected more than 63,000 specimens of plants and animals, a large number new to science. He donated many of his specimens to the British Museum and then fell out with the museum authorities when some of the specimens were damaged. Reportedly, this fight led John Edward Gray, a museum keeper, to dub the zebra *Asinus* (from the Latin for ass and fool) *burchelli* when he described it scientifically. Its genus name was later revised to *Equus*.

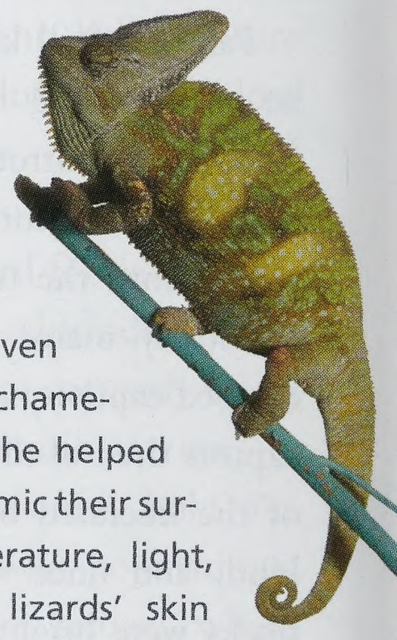
—*Susan Lumpkin*

The estimated speed of a diving peregrine falcon (*Falco peregrinus*) is more than 200 miles per hour, making it the fastest moving bird. The Rüppell's griffon (*Gyps rueppellii*), observed flying 37,000 feet above the Ivory Coast, sets the record for highest flight.

Why Don't Reindeer Get Stuck in Snow?

Reindeer, called caribou (*Rangifer tarandus*) in North America, live in snowy arctic tundra and surrounding boreal forests. They evolved built-in snowshoes—broad, flat, concave hooves with deep clefts—that distribute their weight evenly to keep them from sinking into soft snow and soggy ground. The scoop-shaped hooves also come in handy as shovels when the caribou dig for food, and as paddles when they swim through shallow lakes and swift rivers created by tundra snowmelt. Efficient movement is important for survival in the caribou's harsh habitat, and they need energy for their long migrations. Some caribou travel more than 600 miles each year.

Fact or Fiction: Chameleon Camouflage



If you put a chameleon on a plaid cloth, will it change its skin to match? The answer is no, but even Aristotle was fooled by chameleons' shifting hues, and he helped fuel the myth that they mimic their surroundings. In fact, temperature, light, and mood affect these lizards' skin cells, causing them to change color.

Several layers of a chameleon's skin are studded with cells containing red and yellow pigments, while other cell layers reflect blue and white light. Yet another layer contains the chemical melanin, a dark coloring also present in human skin. Changes in the chameleon's environment or temperament make these cells expand and contract. For example, if a chameleon feels hot, its yellow pigment cells grow larger so it may look yellow; but a cold chameleon's yellow cells may shrink, and it will darken.

In Season

As autumn wanes, timber rattlesnakes (*Crotalus horridus*) congregate near the openings of their winter dens. Loners in the summer, they return to the same communal crevices in wooded, rocky outcrops year after year. Eventually, the cold drives them underground to hibernate until spring. Timber rattlers sometimes share dens, packed with 15 to 60 snakes, with copperheads and black snakes. Native to most of the eastern United States, timber rattlesnakes are threatened by habitat loss and human activity, and some scientists believe they have already disappeared from Delaware.

Dung beetle (*Phanaeus vindex*): Bruce Coleman Inc./Patrick M. Lynch; Grevy's zebra: Gerald & Buff Corsi/California Academy of Sciences; chameleon: Jessie Cohen/NZP; falcon: J'nie Woosley

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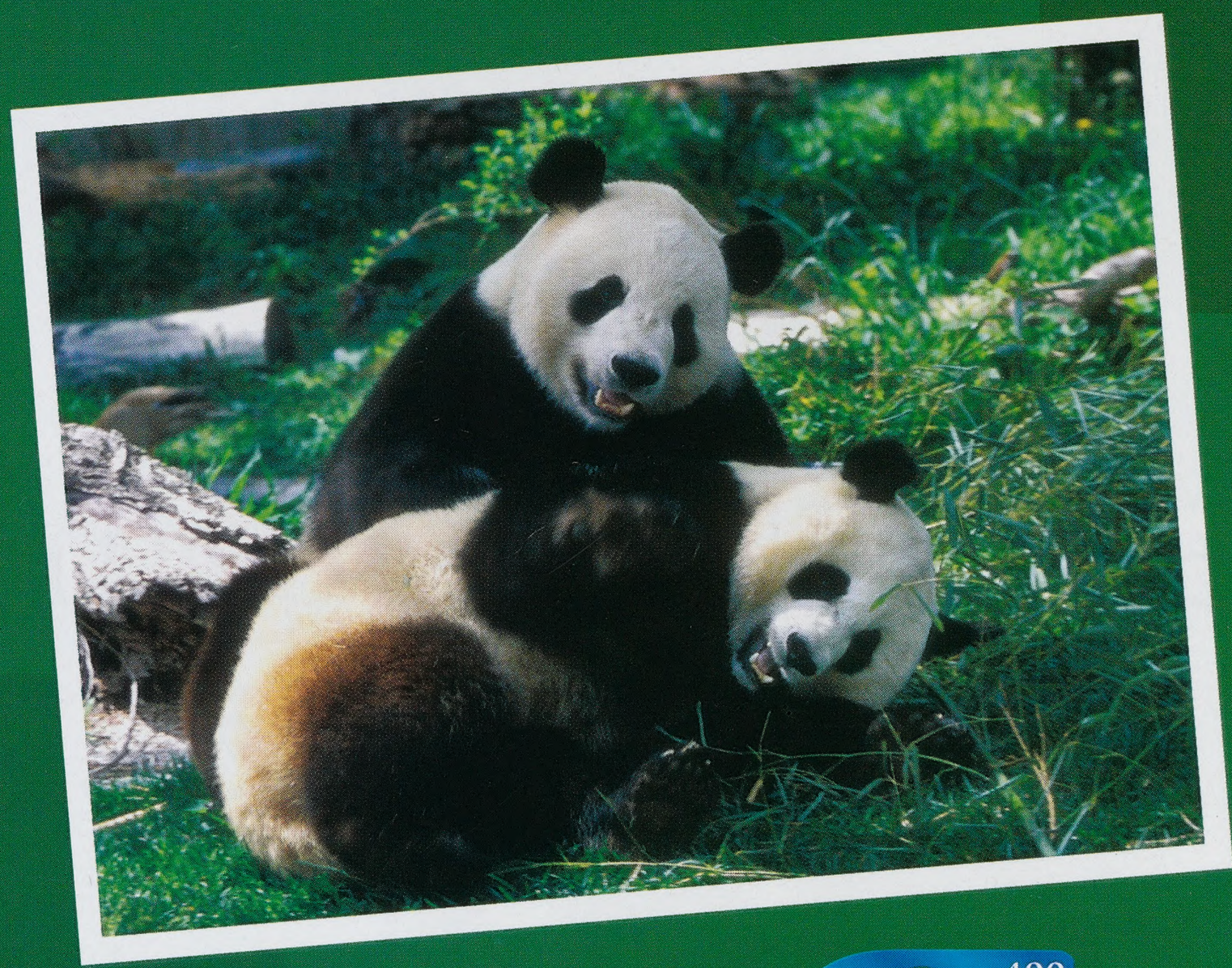

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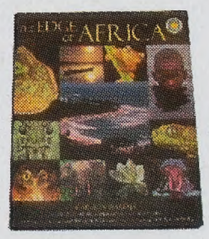

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